Peeling the Onion

Why Centralized Control / Decentralized Execution Works

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Understanding centralized control / decentralized execution has value because the concept links initiative at the tactical level to operational and strategic objectives in a way that is consistent with higher-level intent. For this reason, centralized control / decentralized execution can mitigate some of the joint-air command and control (C2) challenges posed by antiaccess / area denial that put traditional US space and cyber advantages at risk. This article "reblues" the reader regarding the nature of centralized control / decentralized execution, explores theory to determine why it works, and discusses examples and ideas for more effectively using it in future joint-air operations.

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What Is Centralized Control / Decentralized Execution?

Emerging in the aftermath of the North African air campaign during World War II, centralized control / decentralized execution is a foundational concept found within current joint and US Air Force doctrine.[1] Field Manual 100-20, *Command and Employment of Airpower*, notes that "control of available airpower must be exercised through the Air Force commander if inherent flexibility and ability to deliver a decisive blow are to be fully exploited."[2] Furthermore, according to Air Force basic doctrine,

> *Centralized control is commanding airpower* and should be accomplished by an Airman at the air component commander level who maintains a broad focus on the joint force commander's (JFC's) objectives to direct, integrate, prioritize, plan, coordinate, and assess the use of air, space, and cyberspace assets in any contingency across the range of operations. *Centralized control empowers the air component commander to respond to changes in the operational environment and take advantage of fleeting opportunities.*[3] (emphasis in original)

Centralized control enables an air component commander to plan, coordinate, and control the independent and direct-support actions of air forces in such a way that they meet the intent and objectives of the joint force commander.[4] Centralized planning of theater air operations provides a cohesive, integrated plan that meets combatant commander's objectives as part of the joint team. Centralized control supplies the theaterwide span of control necessary to exploit the speed, flexibility, and mass of air and space power to take advantage of unplanned and/or unanticipated opportunities (or vulnerabilities) whenever and wherever they emerge and as resources permit.

In contrast to centralized control, decentralized execution involves giving subordinate commanders the initiative to make decisions based on the best available information, informed by the air component commander's guidance, directives, and rules of engagement (ROE): "Execution should be decentralized within a command and control architec-

ture that exploits the ability of front-line decision makers (such as strike package leaders, air battle managers, forward air controllers) to make on-scene decisions during complex, rapidly unfolding operations."[5]

Although the line between centralized control and decentralized execution may seem clear, it can quickly blur. That said, what allows this concept to work if the distinction is less clear than first appears in the black and white of doctrine? Exploring the importance of situational awareness (SA) offers a good starting point for answering that question.

The Importance of Situational Awareness to Shared Understanding of the Battlespace

The ability of technology to seemingly enhance SA and inform decision making has increased exponentially over the past decade. Data links, Internet relay chat, satellite communications, and full-motion video feeds are among some of the tools available to commanders at all levels. Although technology has placed additional information and options at the fingertips of leaders, it hasn't changed an anecdotal truth: *In general*, SA of what occurs in a tactical engagement is higher for those actually involved in it than for those who monitor it at an operational command center. Inversely, awareness of how an engagement fits into the larger scheme of operational art and strategy is higher at the operational level than at the tactical (fig. 1).[6]

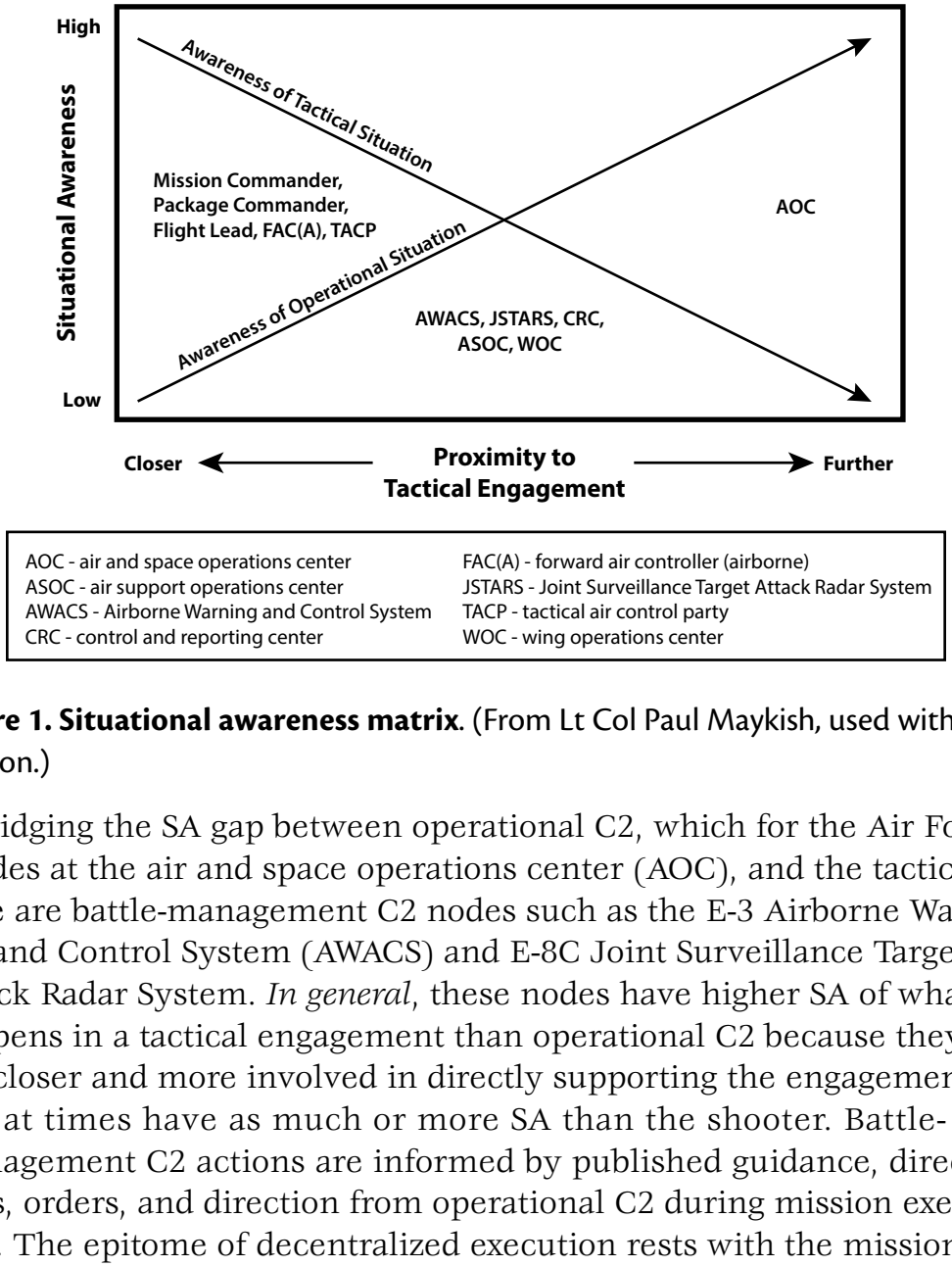

Figure 1. Situational awareness matrix. (From Lt Col Paul Maykish, used with permission.)

Bridging the SA gap between operational C2, which for the Air Force resides at the air and space operations center (AOC), and the tactical edge are battle-management C2 nodes such as the E-3 Airborne Warning and Control System (AWACS) and E-8C Joint Surveillance Target Attack Radar System. *In general*, these nodes have higher SA of what happens in a tactical engagement than operational C2 because they are closer and more involved in directly supporting the engagement and at times have as much or more SA than the shooter. Battle-management C2 actions are informed by published guidance, directives, orders, and direction from operational C2 during mission execution. The epitome of decentralized execution rests with the mission commander, package commander, flight lead, and terminal attack controller. For them, SA over their individual tactical engagement is very high. But how that action fits into the theaterwide perspective of air

operations is understandably limited. Figure 1 generally shows the relationship of SA and proximity to the tactical engagement—it is not all encompassing. For example, a predator feed may serve tactical, operational, and strategic SA simultaneously. However, knowing where SA of the tactical, operational, and strategic situation is highest at a given time would prove helpful to understanding the value of centralized control / decentralized execution.

For instance, consider a notional mission tasked to attack a C2 communications bunker defended by enemy surface-to-air missiles and aircraft as part of an ongoing air campaign. To support the attack, the mission package includes B-1s to strike the target, F-15Cs for offensive counterair sweep, F-16s for suppression of enemy air defenses, and an EA-6B for electronic warfare support. C2 support includes the AOC and an E-3C AWACS. As the mission package begins to marshal for the attack, SA of the battlespace is enhanced by threat updates from the E-3C and an RC-135. In addition to this strike, four other air interdiction missions are under way elsewhere in the battlespace. Moreover, there is an ongoing dynamic targeting effort against theater ballistic missiles.

To the mission commander on the B-1, focused on the tactical objectives of conducting an attack to destroy the bunker, the battlespace encompasses the area immediately surrounding the target, enemy, and friendly assets. The mission commander understands the locations of the target in relation to the air-to-surface threats and has coordinated to suppress them. Based on the situation updates from the E-3C, he coordinates a delayed push by the B-1s to give the F-15Cs time to complete their work. His SA of the upcoming tactical engagement is high due to the proximity to the engagement. However, the mission commander's SA of other interdiction and dynamic targeting missions in the battlespace is understandably limited because of his tactical concentration on issues related to destroying the target.

To the crew of the E-3C, intent on bridging tactical action with operational objectives, the battlespace encompasses the platform's assigned

battle-management area, which is broad because of the E-3's large sensor and communication footprint. Within the area controlled by the E-3C, two other interdiction strikes are occurring elsewhere in the battlespace; furthermore, in addition to the mission to strike the C2 bunker, it is coordinating the search for theater ballistic missiles. The AWACS also provides high-value airborne-asset control, protection, and deconfliction for tankers; intelligence, surveillance, and reconnaissance; and electronic warfare aircraft. Finally, several tankers are airborne with the E-3C controlling the refueling tracks and coordinating the effort with the AOC.

The E-3C crew's awareness of the tactical situation is high because controllers directly support the mission/package commanders. The crew knows about the air threat and the plan to counter it as well as the surface threats. However, their SA is not as high as that of the mission commander on the B-1. A system malfunction prevents one of the B-1s en route to the target from dropping its weapons. During planning, the mission commander developed a contingency plan to prioritize a single B-1's weapons against the priority impact points, leaving lower-priority points intact and the target only partially destroyed. With the attack in progress, the commander does not have time to notify the E-3 of the situation. Because the E-3 strike controller monitors the B-1's communications, though, SA exists regarding the impact points that were not attacked. Understanding the operational priorities, the E-3 mission crew commander reports the mission limitation to the AOC so it can decide whether to rerole assets from other missions to the surviving impact points or to attack them another day.

To the combat operations division of the AOC, concerned with linking strategy to task, the battlespace includes the entire theater. The AOC monitors all four interdiction strikes and the ongoing dynamic targeting effort; it also maintains awareness through updates from battle-management C2 and the common operational picture. Many actions occur simultaneously. During the attack on the C2 bunker, the AOC reacts and responds to a missile strike on a friendly air base and tries to

decide whether to launch an alert tanker to replace one whose launch aborted on the ground. As the single air manager in-theater, the AOC maintains a theater perspective rather than focusing on individual engagements. When the E-3 reports that part of the C2 bunker remains intact, the AOC understands that the bunker is a critical vulnerability of the enemy's integrated air defense system. However, given the report of successful strikes against the highest-priority impact points, the AOC decides for the moment to attack the remaining points later. A theater focus limits the SA of what transpired at the C2 bunker to reporting by the E-3. However, understanding how the attack factored into the bigger picture of operational art remains very high.

In this example, the mission commander on the B-1, the E-3 AWACS crew, and the AOC had SA that matched their emphasis on the tactical, operational, and strategic mission. Although the SA of these three entities differed, they all contributed to an overall mutual understanding that enabled attainment of the objectives tying strategy to task for this one mission. But why does it work? In doctrine, clear lines exist between centralized control and decentralized execution. However, during operations, they tend to blur. Recently, Lt Gen Ralph Jodice, USAF, retired, the former combined force air component commander (CFACC) of Operation Unified Protector, discussed the importance of the AOC and the ability to move quickly between the levels of war (see the table below) "in order to connect strategy to task, task to strategy, and everything in between" since tactical actions can yield strategic effects—as occurred in our example.[7] The next section explores why this works by looking at centralized control / decentralized execution through the lens of C2 theory.

Table. Levels of war

Levels of War	*Definition*	*Examples*
Strategic	Employment of the instruments of national power in a synchronized and integrated fashion to achieve theater, national, and/or multinational objectives	President and Secretary of Defense, Combatant Commander
Operational	Linkage of the tactical employment of forces to national and military strategic objectives	Joint Force Commander, Air and Space Operations Center
Tactical	The employment and ordered arrangement of forces in relation to each other. Joint doctrine focuses this term on planning and executing battles, engagements, and activities at the tactical level to achieve military objectives assigned to tactical units or task forces.	AWACS, JSTARS, Control and Reporting Center, Air Support Operations Center, E-2D Hawkeye, AEGIS Combat System, Wing Operations Center

Source: Compiled by the author. For definitions, see Joint Publication 3-0, *Joint Operations*, 11 August 2011, 36, http://www.dtic.mil/doctrine/new_pubs/jp3_0.pdf.

Exploring Theory: Why Centralized Control / Decentralized Execution Works

In joint-air C2 with shared understanding, the components should function as a system instead of as individual parts functioning separately. Discussing the issue of centralized control / decentralized execution without a holistic perspective equates to a "corps commander telling a sergeant how to put his troops in a foxhole"—probably not the most efficient way to fight.[8] This occurs not because the corps commander has nothing better to do but because the system lacks enough adaptability and flexibility to offer any perceived options.[9] Instead, joint-air C2 should be flexible enough to reposture quickly and/or effectively across the levels of war, depending on the situation, and regain shared understanding rapidly.[10]

So what are we really talking about? Enabling SA to affect shared understanding in a system flexible enough to reposture quickly at the tactical, operational, and strategic levels demands that those with the best SA orient, reorient, and take action appropriate to the situation. To discover how this works, we would do well to reexamine the relevance of Col John Boyd's theories of the observe, orient, decide, act (OODA) loop (fig. 2).

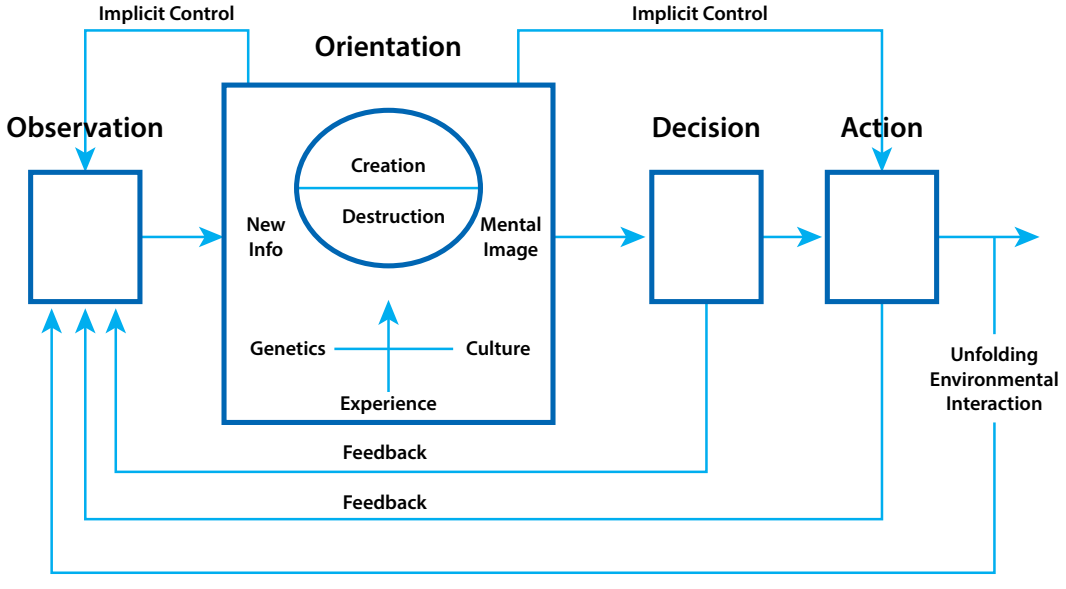

Figure 2. John Boyd's OODA loop. (Reprinted from Lt Col David S. Fadok, "John Boyd and John Warden: Airpower's Quest for Strategic Paralysis," in *The Paths of Heaven: The Evolution of Airpower Theory,* ed. Col Phillip S. Meilinger [Maxwell AFB, AL: Air University Press, 1997], 366.)

Some people criticize the OODA loop as overly simplistic—success on the battlefield simply involves "getting inside an adversary's OODA loop and staying there."[11] The loop lent itself as a model to net-centric warfare (NCW) insofar as both contained the idea that decision-cycle rapidity holds the key to generating enough friction to cause the enemy to look inside, leading to system paralysis.[12] NCW documents make "explicit reference" to the OODA loop, emphasizing the impor-

tance of obtaining and exploiting an information advantage.[13] In the 1990s, when the idea of NCW was taking shape, the concepts of swarming and information dominance inherent in Colonel Boyd's thinking resonated with NCW proponents, and the OODA loop offered an easy way to capture the ideas as a bumper sticker for NCW as a whole. The perceived tie between the loop and rapidity is understandable, given the context of the environment that shaped Boyd's ideas. The latter grew during the post-Vietnam environment of change as the US military turned its attention to winning a war in Western Europe. Perhaps unsurprisingly, Boyd's ideas influenced maneuver warfare and later NCW. Like an overidentified brand name, the OODA loop became synonymous with high-intensity conflict. The authors of an *Armed Forces Journal* article observe that

> the unemployment theory fit our understanding of the problem and, while incorrect, was coherent with an OODA Loop approach. We observed lots of unemployed Sunni in the streets and knew that the same cohort provided manpower for the insurgency. We oriented to the reality that coalition decisions had put them out of work. We decided that works projects would give them employment and take them off the streets. We acted by spending huge amounts of money on projects that were largely ineffectual in fixing the infrastructure or reducing the insurgency. Our mistake was in thinking a fundamentally complex problem—one with so many seen and unseen variables that there are no longer direct correlations between action and outcome—was merely a complicated one, with direct linkages between cause and effect.[14]

Their criticism is consistent with a simplistic view of the OODA loop. However, as a model for learning and adaptation over time, it is only as good as the orientation that informed the decisions and actions. How so? The key to effective orientation involves understanding the complexities of the operating environment, including the cultural/genetic factors, previous experiences, and analysis and synthesis that form the destruction of the various parts contained in disparate information. This is followed by re-creation through synthesis of the vari-

ous parts into orientation on the accurate whole. In this case, the model failed because a lack of understanding of the operational environment (poor mission analysis) and cultural/genetic factors (limited education/experience with Iraqi culture) resulted in an ill-informed orientation and, consequently, poor decisions and actions. Boyd might argue that the OODA loop is just as relevant today if properly applied. However, he might use the word *persistence* instead of *rapidity* in the context of irregular warfare. Consider the mission of Constant Hawk in Iraq where postmission forensic analysis of collected data and fusion with other intelligence sources resulted in disruption of criminal and insurgent networks.[15] Information developed by Constant Hawk proved invaluable in preventing future attacks by enabling effective orientation and disruption of the enemy. It wasn't rapid, but it was persistent and effective. For this reason, the OODA loop—properly understood—may be a viable model across the spectrum of conflict. It is also a viable model at all levels of war since the need to orient exists there as well—from a CFACC to a mission commander. In the words of Frans Osinga, "We need to move well beyond the narrow 'rapid-OODA loop' concept."[16]

Accounting for Friction: Toward More Effective C2 Interaction

It is not enough to assume that one's SA and ability to observe, orient, decide, and act will bridge strategic to tactical objectives. Something has to link initiative at the tactical, operational, and strategic levels to ensure that actions taken are consistent with higher-level intent and objectives. So what are those linkages, and how do they work? Another of Boyd's ideas, the "Organic Design for Command and Control," builds on the ideas of destruction and creation and patterns of conflict to create a framework that inflicts paralysis on the enemy.[17] Boyd articulated four key points during a series of briefings on the subject:

1. The atmosphere of war is friction.
2. Friction is generated and magnified by menace, ambiguity, deception, rapidity, uncertainty, mistrust, etc.
3. Friction is diminished by implicit understanding, trust, cooperation, simplicity, focus, etc.
4. In this sense, variety and rapidity tend to magnify friction, while harmony and initiative tend to diminish friction.[18]

Referring to friction in war, Carl von Clausewitz declares that "everything in war is very simple, but the simplest thing is difficult." He goes on to write that "countless minor incidents—the kind you can never really foresee—combine to lower the general level of performance."[19] The key to Boyd's idea is friction—how to magnify friction for the enemy and diminish it for our side. According to Boyd, a relationship exists between generating enemy friction and maintaining harmony and initiative. In other words, how does a force "generate harmony and initiative in order to exploit variety and rapidity"?[20] A C2 system creates these two elements through interactions that minimize friction and maximize learning and adaptation. Positive interaction mitigates friction while negative interaction induces friction. However, effective orientation does not assure the ability to exploit variety and rapidity. Rather, one must have a system in which implicit trust allows exploitation of what is not explicitly communicated, enabling lower-level initiative to "reduce friction and compress time."[21]

To gain an understanding of how friction occurs and how to mitigate it, one must look at what occurs when the levels of war overlap. These points of overlap are potential friction points resulting from a lack of shared understanding driven by differing SA. For example, an AWACS operator at the tactical level who has better proximity to the engagement may not understand the intent of an AOC operator who coordinates at the tactical level. That operator, who possesses higher operational SA, knows why they are coordinating at the tactical level but has a lower overall awareness of the tactical engagement than the AWACS operator. This disconnect between echelons induces friction, resulting

in increased coordination as each strives to gain shared understanding. Upon attainment of the latter, the AOC operator understands what is possible, and the tactical C2 operator understands what is needed.

Shared understanding is the key to linking actions across the levels of war, and implicit controls are essential to such understanding. These controls (e.g., the air tasking order, air operations directive, and ROEs) help align tactical action with operational intent. Further, they ensure that the actions of battle managers and mission commanders are nested with operational intent. According to Boyd, the payoff is a "command and control system, whose secret lies in what's unstated or not communicated to one another (in an explicit sense) in order to exploit lower-level initiative yet realize higher-level intent, thereby diminish friction and compress time, hence gain."[22] Here, he refers to the implicit controls that bind strategy to task and enable shared understanding of operational intent in time and space. To attain the payoff that Boyd alludes to requires effective integration of implicit controls in higher-level guidance such as the joint air operations plan that considers operational flexibility and risk management.

Flexibility in Action: The Future of Centralized Control / Decentralized Execution

Operational flexibility is a relatively new term.[23] For the purposes of this article, it denotes harmonizing operations to maximize the effectiveness of airpower through the range of military operations. A case in point is the assignment of an air and space expeditionary task force (AETF) commander in Afghanistan as an additive C2 echelon to the theater CFACC. This provides the joint task force (JTF) commander in Afghanistan an air commander with authority over air assets, thus greatly aiding unity of effort by giving the JTF commander a voice. The AETF commander is naturally positioned to harmonize C2 within Afghanistan because of the commander's proximity to the fight.[24]

The concept of the AETF commander lies at the heart of a discussion of C2. The question has to do with when it is appropriate to decentralize control from the theater CFACC in order to better support JTF commanders.[25] In this case, decentralization is necessary to mitigate seams created by the mismatch of centralized planning and control in a theater AOC versus the needs of JTF commanders for decentralized control and execution in a conflict with multiple JTFs.[26]

In contrast, during high-intensity conflict, more centralized control may be required to maintain a theater perspective and to take advantage of airpower's attributes of speed, flexibility, and mass.[27] Similarly, more centralization may prove necessary in operations with strategic impact, especially when political issues demand that operational and strategic decision makers maintain flexibility or mitigate risk.[28] In contrast, more decentralization might accommodate highly intense conflicts that pose substantial risk to forces, the unavailability of or risk to linkages needed for higher-level decision making, or the existence of a decision cycle driven by enemy or friendly tempo that occurs faster than the time available for coordination up and down the chain. Take for example the concept of centralized command / distributed control / decentralized execution. In the end, the nature of the conflict, the need for flexibility, and C2 capacity are considerations for the degree of centralization/decentralization.[29] No finite answers exist; ultimately, the situation will dictate the nature and shape of operational flexibility.

The following illustrates the hazard of failure to apply operational flexibility. During Operation Anaconda—an effort to destroy al-Qaeda and Taliban forces in Afghanistan—the air component was not effectively integrated into planning, thereby leaving it unprepared.[30] The C2 structure at the time involved a theater AOC supporting Operation Enduring Freedom, Operation Southern Watch, and operations in the horn of Africa. Elements of battle-management C2 included AWACS and E-2 aircraft as well as joint terminal attack controllers embedded with land forces. An air liaison officer represented the air component in planning but "did not exert a great deal of influence over the plan."[31]

Consequently, a chaotic, poorly coordinated air effort ensued. The air component rebounded and proved decisive in the end, but lessons of the need for operational flexibility were clear. In the aftermath, the CFACC assigned an air component coordination element to Afghanistan to ensure the unified planning of air operations.[32]

How can we apply operational flexibility in future conflicts? According to Benjamin Lambeth, this process involves enabling lower-level initiative when centralization of execution "would be impossible in a larger war requiring a thousand or more combat sorties and weapon aim points a day."[33] In addition, at a time when assured access to information dominance enabled by space and cyber is at risk—coupled with long distances in certain areas that require distributed operations using beyond-line-of-sight communications—we have created an exploitable vulnerability. Command and control of air operations involves developing a C2 structure that exploits operational flexibility to allow C2 to continue functioning (what Boyd would call a noncooperative center of gravity for the enemy) even when our traditional advantages degrade.[34]

Operational flexibility is only part of the equation. Implicit controls also include risk assessment and products that facilitate shared understanding. Assessment, which can help determine the need for decentralization, is part of the joint operations planning process for air and continues in execution as part of the joint air tasking cycle.[35] During planning, risk is identified during mission analysis and characterized in terms of its severity and the frequency with which it manifests. Course-of-action development further refines risk and identifies mitigation measures. Within the joint air tasking cycle, risk assessment remains an ongoing function of the development of an air operations directive in the AOC's strategy division. Characterizing risk as it applies to decentralization and, more specifically, as it relates to implicit controls is a factor of both ROEs and risk to force.

Generally, an inverse relationship exists between decentralization and ROEs. The more restrictive the rules, the less likely that tasks re-

lated to engaging the enemy will be decentralized. Contrastingly, the less restrictive the ROEs, the more likely the tasks related to engaging the enemy will be decentralized.[36] Unlike irregular warfare, in a high-end fight against a peer adversary, decentralization as a risk-mitigation measure may be needed in a conflict in which an advanced enemy can challenge decision making by denying assured access to distributed communications and battlespace awareness. In a conflict of this nature, decentralization of C2 may prove critical to victory, and it is one of many reasons that battle-management C2 has value near the tactical edge. Although the effort to characterize and mitigate risk occurs in planning, it should be systematically reevaluated during execution. Doing so ensures the flexibility to adjust course and become more or less restrictive in the decentralization of C2 should the nature, phase, or constraints of the conflict require.

Another risk-management consideration concerns the risk to forces. Decentralization of C2 during a peer conflict offers a way of mitigating risk to forces and continuing the fight should critical linkages be lost, as well as a way of countering the enemy's pace and initiative. Decentralization includes risk-mitigation measures and operational flexibility that shape the nature of the products of implicit control.

Several of these products enable joint-air C2, including a joint air operations plan, an air operations directive, an area air defense plan, ROEs, an air tasking order, and so forth. Embedded within them are the guidance, direction, and details necessary for shared understanding between echelons of the commander's intent and objectives together with the game plan to make it happen—operational art. However, despite these implicit controls, friction remains. To reduce it, we need a flexible process that details levels of decentralization and is adaptable to changing situations. During development of this matrix (fig. 3), planners should consider the operational environment, including the commander's intent, threat, mission, risk to forces, and ROEs.

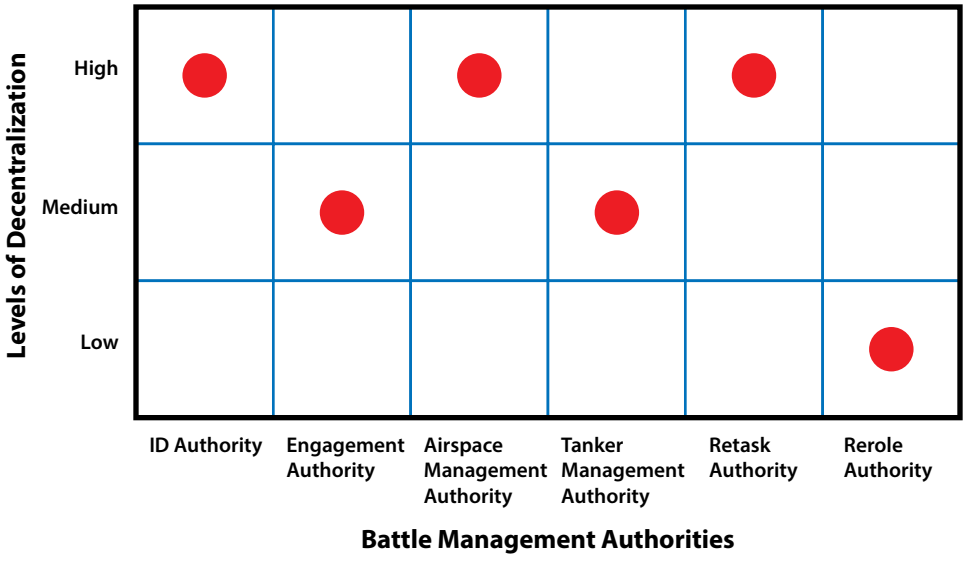

Figure 3. Sample tactical C2 decentralization matrix

Development of the matrix calls for a three-phase process resulting in published guidance. First, air component campaign planners should develop a by-phase matrix included in the C2 annex of the joint air operations plan. Second, matrix refinement should be part of the normal joint air tasking cycle. The risk assessment for the air operations directive, produced by the AOC's strategy division, should form the baseline for determining levels of decentralization that can be further refined by the combat plans division and then be promulgated in the air tasking order's special instructions. Finally, the AOC's combat operations division should use the matrix to adjust levels of decentralization based on unfolding circumstances and to provide guidance for battle-management C2 or mission commanders in the event of loss or denial of communication with the AOC. This matrix should reduce friction by improving adaptability and should facilitate shared understanding in joint air operations.

A case study of airspace challenges during Operation Anaconda illustrates the importance of implicit control, noting that the airspace structure could not support the pace of operations and amount of air

activity. This situation compromised safety for the combatants on the ground, aircrews, and civilian airliners operating on an air route above the valley.[37] According to an Air Force doctrine publication, the problem stemmed from a lack of planning: "Normal airspace planning would have accounted for this earlier."[38] However, how would normal planning have helped? The air component did not even know that it needed to plan because implicit control was absent, creating friction as the operation unfolded due to a lack of shared understanding. Applying operational flexibility, including assignment of an air component coordination element as soon as the JTF commander was on the ground in Afghanistan, would have enabled adequate allocation of forces for planning. Furthermore, a risk assessment that balanced ROEs with risk to force would have produced decentralization of airspace management to battle-management C2. Finally, it would have led to the development of products that support shared understanding, including an airspace control plan/order, clear priorities and intent of an air operations directive, and so forth. Mission-type orders, an additional method of implicit control effectively utilized in recent decentralized ISR operations, contribute to successful missions.

Conclusion

A winning formula for joint-air C2 in antiaccess / area denial involves a system with the initiative to act at the tactical level, based on SA linked to higher-level intent by effective, implicit controls. Further, refining such C2 through the application of operational flexibility can optimize the system for the operational environment and enable its reposturing as events warrant. This article has addressed the nature of centralized control / decentralized execution, explored theory to reveal the way it works, and discussed ideas for its effective use in future joint air operations.

Notes

1. Curtis E. LeMay Center for Doctrine Development and Education, *Volume I, Basic Doctrine*, 14 October 2011, 59–60, https://doctrine.af.mil/download.jsp?filename=Volume-1-Basic-Doctrine.pdf (hereafter *Basic Doctrine*); and JP 3-30, *Command and Control for Joint Air Operations*, January 2010, 26.
2. Field Manual 100-20, *Command and Employment of Airpower*, 21 July 1943, 53.
3. *Basic Doctrine*, 59.
4. Col Edward C. Mann III, *Thunder and Lightning: Desert Storm and the Airpower Debates* (Maxwell AFB, AL: Air University Press, 1995), 53–54, http://www.au.af.mil/au/awc/awcgate/au/mann.pdf.
5. *Basic Doctrine*, 60.
6. During a white-board presentation by Lt Col Paul Maykish, he offered a simple method of discussing SA at various levels. I have used it in a number of forums over the years and have found it an effective way of quickly communicating the variance in SA among different echelons.
7. Lt Gen Ralph Jodice (speech to Air Command and Staff College, Maxwell AFB, AL, 29 February 2012) (used with permission).
8. Col Luke Grossman, interview by the author, 16 December 2012 (used with permission). Colonel Grossman was assigned to the equivalent of the combat operations division in the AOC during Operation Allied Force. He also served as vice-commander of the 332nd Air Expeditionary Wing at Balad AB, Iraq, from 2009 to 2010.
9. Ibid.
10. Ibid.
11. Lt Col David S. Fadok, "John Boyd and John Warden: Airpower's Quest for Strategic Paralysis," in *The Paths of Heaven: The Evolution of Airpower Theory*, ed. Col Phillip S. Meilinger (Maxwell AFB, AL: Air University Press, 1997), 367.
12. Frans Osinga, "John Boyd and Strategic Theory in the Postmodern Era," [2007], 1, http://www.au.af.mil/au/awc/awcgate/boyd/osinga_boyd_postmod_copyright2007.pdf.
13. Ibid., 5.
14. Col Kevin Benson and Col Steven Rotkoff, "Goodbye, OODA Loop," *Armed Forces Journal* 149, no. 3 (October 2011), http://www.armedforcesjournal.com/goodbye-ooda-loop/.
15. Constant Hawk was an airborne, persistent, wide-area surveillance capability employed in Iraq.
16. Osinga, "John Boyd and Strategic Theory," 12 (see note 18).
17. John Boyd, "Organic Design for Command and Control" (PowerPoint re-creation of original briefings), http://www.ausairpower.net/JRB/organic_design.ppt.
18. Ibid., 8.
19. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976,) 119.
20. Boyd, "Organic Design," 9.
21. Ibid., 18.
22. Ibid., 17.

23. This idea was first articulated to me by Mr. Richard Perry during a discussion about the cross domain operator on US Air Force C2.

24. Ibid.

25. Lt Col Jeffrey Hukill, USAF, retired, and Dr. Daniel R. Mortensen, "Developing Flexible Command and Control of Airpower," *Air and Space Power Journal* 25, no. 1 (Spring 2011): 54, http://www.airpower.maxwell.af.mil/airchronicles/apj/2011/2011-1/2011_1_03_hukill_mortensen.pdf.

26. Ibid.

27. Ibid., 57.

28. Lt Col Clint Hinote, *Centralized Control and Decentralized Execution: A Catchphrase in Crisis?* Research Paper 2009-1 (Maxwell AFB, AL: Air Force Research Institute, 2009,) 59–61.

29. Ibid.

30. Benjamin S. Lambeth, "Operation Enduring Freedom, 2001," in *A History of Air Warfare*, ed. John Andreas Olsen (Washington, DC: Potomac Books, 2010), 269.

31. Richard Kuglar, *Operation* Anaconda *in Afghanistan*: *A Case Study of Adaptation in Battle*, Case Studies in Defense Transformation no. 5 (Fort Lesley J. McNair, DC: National Defense University Center for Technology and National Security Policy, 2007), 13, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA463075.

32. The "air component coordination element" is now known as the "joint air component coordination element."

33. Lambeth, "Operation Enduring Freedom, 2001," 275.

34. Boyd, "Organic Design."

35. Curtis E. LeMay Center for Doctrine Development and Education, *Volume 4, Operations*, 5 June 2013, 6–7, https://doctrine.af.mil/download.jsp?filename=Volume-4-Operations.pdf.

36. Hinote, *Centralized Control and Decentralized Execution*, 60–61.

37. Curtis E. LeMay Center for Doctrine Development and Education, "Annex 3-52, Airspace Control," 2 February 2011, 14, https://doctrine.af.mil/download.jsp?filename=3-52-Annex-AIRSPACE-CONTROL.pdf.

38. Ibid.

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